

In the Claims:

Cancel claims 2-11 without estoppel or disclaimer of the subject matter thereof, and add new claims 1-10, as follows:

WHAT IS CLAIMED IS:

1. A contour extraction apparatus extracting at least one contour of a target object from images obtained by an image pickup of the target object by cameras, the contour extraction apparatus comprising:

a node locator locating a plurality of nodes on a periphery of a region, which includes the target object, within the image;

a contour deformation unit deforming the contour, which is formed by connecting nodes at a predetermined connection order, by shifting the position of each node to the position where a predefined energy function becomes minimum;

an internode distance calculator measuring internode distances about all combination of nodes constituting the contour excepting the internode distance between adjacent nodes; and

a connection creator creating a connection line to divide the contour when a combination of nodes whose internode distance is below a first threshold value exists, wherein

the connection line connects one of nodes in the combination with the node adjacent to the other node in the combination,

the node adjacent to the other node is the node being positioning upstream or downstream in the predetermined connection order with respect to the other node, and

the first threshold value is determined in accordance with the distance to the target object.

2. A contour extraction apparatus according to claim 1, wherein

the first threshold value is set large as the distance to the target object becomes short.

3. A contour extraction apparatus according to claim 2, further comprising:

a target region determination unit determining the region, which includes pixels of the target object, as a target region based on distance information, motion information, and edge information, each information is generated for the target object from the image, wherein

the node locator locates a plurality of nodes on a periphery of the target region determined by the target region determination unit.

4. A contour extraction apparatus according to claim 3, wherein  
the target region determination unit: detects as a target distance the distance wherein a total number of pixel in which motion has been detected exceeds a second threshold value; obtains edge information of pixels corresponding to the image within a region which has a predetermined depth in a fore-and-rear direction from the target distance; and determines the target region based on a centerline, the center line is a pixel array in which a total number of pixels corresponding to an edge is maximum, the pixel corresponding to the edge is searched based on edge information.
5. A contour extraction apparatus according to claim 4 wherein  
the target region determination unit establishes as the target region the rectangular region which has 2 meter height and has 50 centimeter width in a left-and-right direction from the centerline.
6. A contour extraction apparatus according to claim 3, wherein  
the target region determination unit terminates the establishment of new target region, when a predetermined number of contours have been established or when new target region cannot be detected.

7. A contour extraction apparatus according to 6, wherein  
the target region determination unit determines new target region from the region other than the region from which the contour has been extracted and the region which has been judged as the region the target object is not in.
8. A contour extraction apparatus according to claim 3, wherein  
the target region determination unit establishes the target region further using color information obtained from the camera.
9. A method for extracting at least one contour of a target object from images obtained by an image pickup of the target object by cameras, the method comprising the steps of:
  - a node locating step locating a plurality of nodes on a periphery of a region, which includes the target object, within the image;
  - a contour deforming step deforming the contour, which is formed by connecting nodes at a predetermined connection order, by shifting the position of each node to the position where a predefined energy function becomes minimum;
  - an internode distance calculating step measuring internode distances about all combination of nodes constituting the contour excepting the internode distance between adjacent nodes; and

a connection creating step creating a connection line to divide the contour when a combination of nodes whose internode distance is below a first threshold value exists, wherein

the connection line connects one of nodes in the combination with the node adjacent to the other node in the combination,

the node adjacent to the other node is the node being positioning upstream or downstream in the predetermined connection order with respect to the other node, and

the first threshold value is determined in accordance with the distance to the target object.

10. A program which operates a computer for extracting at least one contour of a target object from images obtained by an image pickup of the target object by cameras, the program controls the computer to represent the functions of :

a node locator locating a plurality of nodes on a periphery of a region, which includes the target object, within the image;

a contour deformation unit deforming the contour, which is formed by connecting nodes at a predetermined connection order, by shifting the position of each node to the position where the predefined energy function becomes minimum;

an internode distance calculator measuring internode distances about all combination of nodes constituting the contour excepting the internode distance between adjacent nodes; and

a connection creator creating a connection line to divide the contour when a combination of nodes whose internode distance is below a first threshold value exists, wherein

the connection line connects one of nodes in the combination with the node adjacent to the other node in the combination,

the node adjacent to the other node is the node being positioning upstream or downstream in the predetermined connection order with respect to the other node, and

the first threshold value is determined in accordance with the distance to the target object.